

Development of Algorithms and Strategies for Monitoring Chlorophyll and Primary Productivity in Coastal Ocean, Estuarine and Inland Water Ecosystems

Semi-Annual Technical Report: NAS5-96063
July 15, 2002

Janet W. Campbell
University of New Hampshire
Durham, New Hampshire 03824

Summary

This is the semi-annual technical report for the period January through June 2002 for the Execution Phase of my MODIS Instrument Team investigator project. The objectives of this work are:

- Establish a protocol for developing regional or site-specific bio-optical algorithms for coastal “case 2” waters.
- Prescribe a protocol for “stitching together” local or site-specific algorithms.
- Demonstrate these protocols in two coastal seas: the Gulf of Maine/Mid-Atlantic region, and the Yellow Sea/East China Sea region.
- Develop a strategy for monitoring coastal oceans, estuaries, and inland waters.

This report reflects the efforts of a research team consisting of myself, two staff scientists (Dr. Mark Dowell and Timothy Moore), and one Ph.D. student (Seung-Hyun Son).

Papers published or submitted:

1. Liu, A.K., Y. Zhao, W.E. Esaias, J. W. Campbell, T. S. Moore. “Ocean Surface Layer Drift Revealed by Satellite Data.” EOS, Transactions, American Geophysical Union, Vol. 83, No. 7, 12 February 2002, 61-62, 64.
2. J. Campbell, D. Antoine, R. Armstrong, K. Arrigo, W. Balch, R. Barber, M. Behrenfeld, R. Bidigare, J. Bishop, M-E Carr, W. Esaias, P. Falkowski, N. Hoepffner, R. Iverson, D. Kiefer, S. Lohrenz, J. Marra, A. Morel, J. Ryan, V. Vedernikov, K. Waters, C. Yentsch, and J. Yoder “Comparison of algorithms for estimating ocean primary productivity from surface chlorophyll, temperature, and irradiance.” *Global Biogeochemical Cycles*, (in press, July 2002).
3. Mahadevan, A. and J. W. Campbell. “Biogeochemical Variability at the Sea Surface” *Geophysical Research Letters*, (in press, July 2001).

4. Mahadevan, A. and J.W. Campbell. "Biogeochemical Variability at the Sea Surface: How it is linked to process response times." Chapter accepted to be published in *Scales in Ecology*, CRC Press, Laurent Seuront, editor.
5. Campbell, J.W., T.S. Moore, Mark D. Dowell, "Observing Dynamic Bio-optical Provinces: A Global Study," (submitted to JGR, Aug. 2001, no response as of July 2002).

Presentations (Jan-June 2001):

6. Janet Campbell, "The Role of Satellite Remote Sensing in Monitoring Water Quality: Addressing Goals of the 2000 Chesapeake Bay Agreement." Presented at Workshop on Applications of Remote Sensing and In-situ Sensors, Maryland Sea Grant, January 7-8, 2002.
7. Amala Mahadevan and Janet Campbell. "Biogeochemical Patchiness at the Sea Surface" Poster presented at the Ocean Sciences Meeting, Honolulu, Feb. 2002.
8. Mark Dowell, Janet Campbell and Timothy Moore. "Dynamic ecological provinces: A biogeochemical and physiological template for the global ocean" JGOFS Conference on "Global Ocean Productivity and the Fluxes of Carbon and Nutrients: Combining Observations and Models," JRC Ispra, Italy, June 24-27, 2002.

Case 2 Algorithm Protocol Development

There are two areas of algorithm development that are addressed in this project. One is the bio-optical algorithm that retrieves chlorophyll and other optically-active constituent concentrations. The second area is the primary productivity algorithm.

Bio-optical algorithms

Progress in this area has been slow. A manuscript (paper # 5) describing global bio-optical provinces was submitted in August 2001 to the Journal of Geophysical Research. We have not heard anything from the editors regarding that paper. We are mining the SeaBASS archive at GSFC to acquire in-situ data for parameterizing algorithms for the global bio-optical provinces described in our January 2002 semi-annual technical report.

Primary productivity algorithms

We continue to make progress in this area as described in the January 2002 technical report. Dr. Mark Dowell has been funded by NASA's Earth Sciences Enterprise (under the Oceans, Ice and Climate NRA released last year) to pursue this work. The graduate student (Seung-Hyun Son) who is working on primary productivity algorithms for the Yellow Sea passed his qualifying exam and is now working full-time on his dissertation. He is using MODIS data in this research.

Demonstration in Gulf of Maine and Yellow Sea Regions

We are continuing to assemble a database of in-situ bio-optical data for the two demonstration sites: Gulf of Maine and Yellow Sea. Our use of MODIS data has been delayed, as we were awaiting the reprocessing which began in early June of this year.

We are planning to serve MODIS data for the Gulf of Maine (including blended chlorophyll and primary productivity maps) through a new web-based server being developed within the Institute for the Study of Earth, Oceans and Space. The new system is being developed to provide data and associated services for coastal ocean observation and analysis. Over the next few months, we will begin to place our MODIS data for the Gulf of Maine onto this web-based data server.

Development of Monitoring Strategies

No further progress has been made in this area. The establishment of a web-based server and the reprocessing of MODIS data will facilitate progress in this area.

Support of MODIS Ocean Team Activities

During this reporting period, we have been active in the evaluation and validation of MODIS products in support of new codes applied to the forward processing and to reprocessing. The new codes were put into operation in June 2002. The MODIS Oceans Team has held weekly teleconferences to discuss issues raised during this phase. We have continued to evaluate MODIS chlorophyll products and compare them with SeaWiFS chlorophyll data acquired at the same location and on the same day. Comparisons presented at the MODIS Science Team meeting in Baltimore, December 2001, were based on MODIS Collection 3 data, and Version 3 of the SeaWiFS processing. Beginning in June, MODIS began generating products according to the Collection 4 processing codes, and just last week (June 8) data from SeaWiFS Version 4 processing were made available. We are now prepared to make a comparison of these products at the upcoming MODIS Science Team Meeting on July 22-24, 2002.

We have assumed responsibility for the chlor_a_2 product. Based on recommendations made in April 2001, the algorithm for chlor_a_2 was changed to the OC3M algorithm to be more consistent with the current SeaWiFS chlorophyll (NASA TM 2000-206892, Vol. 11). I have prepared an overview document that summarizes the various MODIS chlorophyll products and refers (links) to the respective Quality Summaries. In addition, I prepared a Quality Summary for the chlor_a_2 product.

I will continue to evaluate and be responsible for the chlor_a_2 product.

Progress in Related Areas

Amala Mahadevan and I are exploring a simple technique for characterizing scales of variability in surface waters (papers #3, #4 and #7). This work aims to characterize the spatial

distributions of various tracers in terms of a variance-based measure of their patchiness. Using a scaling argument and a numerical model, we relate the patchiness of a tracer distribution to the characteristic response time of the tracer to processes that alter its concentration in the upper ocean. This enables us to relate the distributions of different tracers in the upper ocean and provide an estimate for the relative size of the grid spacing needed to observe or model different tracers. In paper #4, we applied this method to MODIS chlorophyll and SST data. The MODIS data are particularly suited to this analysis because of the simultaneous acquisition of both SST and chlorophyll. Previously (in paper #3) we applied it to SeaWiFS and AVHRR data acquired on the same day at the same place, but the time differences between the two satellite overpasses made direct comparisons much more difficult.

No further progress has been made on the IOCCG report on Binning Algorithms described in the January 2002 technical report.

Mark Dowell is participating in the current Primary Productivity Algorithm Round Robin exercise with his global province-based algorithms. Mary-Elena Carr (JPL) is taking the lead in conducting this activity. His progress in this area was reported by Mary-Elena Carr at the Ocean Sciences Meeting, Honolulu, February 2002, and again at the JGOFS Conference on "Global Ocean Productivity and the Fluxes of Carbon and Nutrients: Combining Observations and Models," JRC Ispra, Italy, June 24-27, 2002.